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FOREST SERVICE
FOREST PRODUCTS LABORATORY
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UTILIZATION OF UNCURED RESIN IMPREGNATED PAPER SCRAP[1]

By MELBURN HEINIG, Assistant Chemist
and F. A. SIMMONDS, Chemist

Introduction

In the commercial production of paper-base laminated plastic, substantial amounts of uncured resin-impregnated paper scrap in the form of trimmings and rejects can be accumulated. The resin content of this material may average 35 percent. It was believed that there would be an economic advantage of reclaiming the scrap provided it can be handled in the paper mill without undue difficulty, that resin retention is high, and that a product of reasonable quality can be obtained. This report presents the results of a limited number of trials made for obtaining information on the possibility of reclaiming scrap resin-impregnated paper.

Summary of Conclusions

The satisfactory properties of paper-base laminated plastics made from papers containing reclaimed, uncured, resin-impregnated paper scrap ranging up to 100 percent, combined with the fact that no serious difficulty was encountered in reworking the scrap, indicate the practicability of the re-use of such material. In making paper commercially from this material, however, consideration should be given to the desirability of a closed white water system in order to obviate any possible toxic effects of the effluent.

Scope of Work

Several furnishes containing various amounts of repulped, resin-impregnated paper scrap from a commercial source and new commercial sulfite pulp, with a maximum test of 100 percent of scrap, were made into paper on a Fourdrinier machine with ordinary operating technique. The paper containing only scrap material was molded, both with and without prior addition of resin by impregnation. All other papers were impregnated with additional resin, prior to molding, with the amounts added estimated to yield a final total resin content of about 35 percent. Certain physical properties of the test panels were determined.

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[1] This mimeograph is one of a series of progress reports prepared by the Forest Products Laboratory to further the Nation's war effort. Results here reported are preliminary and may be revised as additional data become available.

Furnish Preparation and Paper Making

The paper scrap had been made from black spruce unbleached Mitscherlich pulp and was impregnated with Bakelite resin BV-16526. A quantity of the scrap was beaten with the roll at the bedplate setting for 25 minutes at a temperature of about 20° C. and a consistence, based on fiber, of 4 percent. Pronounced foaming occurred at the start of beating, but this trouble was eliminated by the addition of kerosene in a volume equivalent to 1.4 gallons per ton of scrap. Although at the end of the beating treatment small flakes of unfiberized paper still persisted, further processing would have resulted in a paper too low in absorbency for impregnating.

The repulped scrap was used for making papers containing 100, 50, 25, and 15 percent of scrap by adding a commercial unbleached Mitscherlich sulfite pulp made from black spruce. This pulp was a part of a shipment used in establishing a standard laminated paper plastic (papreg) at the U. S. Forest Products Laboratory in June 1943. No trouble was encountered in running the foregoing furnishes on the paper machine.

As each run of paper was made, a sample of the wet web was taken off the first wet press. When the paper contained 100 percent scrap material a sample of white water was also collected. The wet web samples and the white water solids were then extracted with acetone, and the amounts soluble were considered as indications of the resin content.

Preparation and Testing of Panels

Duplicate impregnation runs were made on each paper using Bakelite resin BV-16526. The aim was to add enough resin to bring the total amount to about 35 percent based on the resin-treated sheet. Reference to table 1 reveals that, with the exception of one panel, which consisted of reclaimed scrap only, without added resin, the total resin content ranged between 33 and 36 percent. The total resin content values are based on the amount of resin added and the resin content of the paper prior to impregnation, which is determined by the percentage of acetone-soluble material of the wet web sample.

Molding and testing conditions and results are given in table 1. Panels fabricated from paper impregnated in the first series of impregnation runs, identified as Nos. 2404-1, 2405-1, 2406-1, and 2407-1, were sent to the mill from which the scrap resin-impregnated paper was obtained. The test data shown in table 1 for these panels are those reported by the mill. The second set of panels, identified as Nos. 2404, 2404-2, 2405-2, 2406-2, and 2407-2, were molded from paper impregnated in the second series of impregnation runs and were tested at the U. S. Forest Products Laboratory. Because of the condition, and low content, of the resin in the paper used in molding panel No. 2404, the high pressure of 1,500 pounds per square inch was selected arbitrarily to assure lamination. The minimum pressure necessary was not determined. The addition, by impregnation, of 15 percent resin to this paper resulted in a material moldable at 250 pounds per square inch from which panels Nos. 2404-1 and

2404-2 were made. Test values for the Forest Products Laboratory June 1943 standard papreg containing the same pulp used in the present study are included in table 1 for comparison.

Discussion of Results and Conclusions

The plastic, No. 2404, containing only the reclaimed resin-impregnated scrap, with no added resin, and laminated at a pressure of 1,500 pounds per square inch, although low in actual water resistance, compares favorably in strength properties with those recently published for a commercial high-strength paper-base laminate[2] and also with those of the Forest Products Laboratory June 1943 standard. The water absorption of 4.2 percent observed for this plastic is, however, only 5 percent more than the upper limit given for the commercial product. The addition of 15 percent resin (Nos. 2404-1 and 2404-2) improved water resistance markedly. The average water resistance of 2.2 percent appears especially good for the average specific gravity of only 1.32, as compared with water resistance and specific gravity values of 2.4 and 1.40, respectively, of the June 1943 standard which contained only virgin pulp and resin.

The values for the properties of plastic No. 2404 and the average values for Nos. 2404-1 and 2404-2 (100 percent scrap with added resin) are compared with the corresponding values for the June 1943 standard in table 2, in which the values for the standard papreg are taken as 100 for each property.

The results for the mixed furnishes, in comparison with the June 1943 standard, show that when up to 50 percent of scrap was used 80 percent of the modulus of elasticity in tension was retained with no sacrifice in the other physical properties that were evaluated.

Although the work reported here is limited, the results indicate the practicability of utilizing resin-impregnated paper scrap in laminates that are not required to meet high strength specifications in all properties.[3]

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[2]Plastics Catalogue, Plastics Catalogue Corporation, New York. 1944. Page 768.

[3]Since this work was done, TAPPI Bulletin No. 26, February 19, 1944, mentions the production of paper-base plastic containing reclaimed uncured resin-impregnated fabric scrap.

Table 1.--Physical and mechanical properties of cross-laminated paper-base plastics containing resin-impregnated paper scrap

Plastic number	Furnish for paper: Reclaimed resin-impregnated paper[1]	Furnish for paper: Unbleached Mitscherlich sulfite pulp	Resin content of paper: Reclaimed resin[2]	Resin content of paper: Added resin[3]	Resin content of paper: Total resin	Conditions of laminating[4]: Volatile content	Conditions of laminating[4]: Pressure	Properties of plastics[5]: Tension: Ultimate	Tension: Modulus of elasticity	Flexure: Modulus of rupture	Flexure: Modulus of elasticity	Compression, edgewise: Maximum	Compression, edgewise: Yield strength at 0.2 percent strain offset	Compression, edgewise: Modulus of elasticity	Shear[6]: Modulus of rigidity	Izod impact: Flatwise	Izod impact: Edgewise	Specific gravity	Water absorption	Dimensional change: Length	Dimensional change: Width	Dimensional change: Thickness
	Percent	Percent	Percent	Percent	Percent	Percent	Lb. per sq. in.	Lb. per sq. in.	1,000 lb. per sq. in.	Lb. per sq. in.	1,000 lb. per sq. in.	Lb. per sq. in.	Lb. per sq. in.	1,000 lb. per sq. in.	1,000 lb. per sq. in.	Ft.-lb. per inch of notch			Percent	Percent	Percent	Percent
Cross-laminated paper-base plastics containing resin-impregnated paper scrap																						
2404	100	0	24	0	[2]24		1,500	29,490	2,754			19,180	11,800	2,320	890	4.05	0.86	[7]1.42	4.2	0.03	0.00	3.9
2404-1	100	0	24	15	35	5.1	250	24,800	2,020	29,400	1,800	21.900						1.30	2.0			
2404-2	100	0	24	15	35	5.2	250	26,630	2,141			20,330	10,030	1.864	774	2.73	.67	[7]1.33	2.4	.06	.07	1.4
2405-1	50	50	12	21	31	5.0	250	26,400	2,180	30,500	2,070	20.100						1.31	2.1			
2405-2	50	50	12	25	34	5.2	250					17.840	10,810	1,998	816	3.49	.73	[7]1.28	3.6	.03	.03	2.3
2406-1	25	75	5	29	33	5.5	250	28,600	2,270	31.300	2.240	18.900						1.35	1.9			
2406-2	25	75	5	29	33	6.0	250					20.800	10,570	2,217	815	3.38	.73	[7]1.39	2.3	.03	.01	2.0
2407-1	15	85	2	33	34	5.5	250	28,900	2.230	30.300	2,270	18.900						1.39	2.3			
2407-2	15	85	2	33	34	6.0	250					19,200	10,700	2,240	859	3.48	.72	[7]1.38	2.5	.04	.00	2.1
Forest Products Laboratory Standard of June 1943, cross-laminated paper[8]																						
		100			36.3	4.5	250	27,160	2,692	30,540	2,241	20,800	11.300	2,280	887	3.82	.66	[7]1.40	2.4	.03	.02	1.82
Commercial high-strength paper-base plastic, cross-laminated[9]							75	25,000	2,200	26.000	2,000	18.000				4.00	.70	1.35 to 1.40	2 to 4			

[1] Made commercially from unbleached Mitscherlich sulfite pulp.

[2] Determined by extraction, with acetone, of a sample taken at the first wet press of the paper machine. Percentage based on the oven-dry sample.

[3] BV16526 resin used. Percentage based on final treated sheet.

[4] All experimental panels were pressed at 325° F.; those 1/8 inch in thickness for 12 minutes, and those 1/2 inch in thickness for 30 minutes, and hot drawn.

[5] Tests made according to Federal Specification L-P-406 for Organic Plastics; General Specification (Method of Physical Test) Dec. 9, 1942. Properties of panels 2404, 2405-2, 2406-2, and 2407-2 determined by the Forest Products Laboratory are the average of 3 tension, 4 compression, 4 shear modulus, 8 impact, and 2 water absorption tests of each panel. Compression and impact tests were on material 1/2 inch in thickness, whereas all other tests were on nominal 1/8-inch material.

[6] Modulus associated with shear distortion in the original surfaces and planes parallel thereto. Plate shear tests (mimeograph 1301) on full thickness of plastic.

[7] Based on weight and volume at time of test.

[8] Values represent the arithmetic average of from 9 to 32 tests.

[9] Plastics Catalogue, Plastics Catalogue Corporation, New York, 1941, page 768.

Table 2.--Properties of the plastic made from resin-impregnated paper scrap compared with those of the Forest Products Laboratory June 1943 standard for papreg with the values of the standard papreg taken as 100.

Property	Plastic No. 2404	Average of plastic Nos. 2404-1 and 2404-2
Tension:		
Ultimate	108	91
Modulus of elasticity	102	75
Flexure:		
Modulus of rupture	---	96
Modulus of elasticity	---	80
Compression:		
Maximum	92	100
Yield at 0.2 percent strain offset	104	91
Modulus of elasticity	102	82
Modulus of rigidity	100	87
Izod impact:		
Flatwise	106	71
Edgewise	130	100
Specific gravity	101	94
Water absorption	175	92

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